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EDITORIAL

Body composition in COPD; stepping back or moving forward?

The past two decades epidemiological and clinical intervention studies have consistently shown that muscle wasting is an important therapeutic target to compress COPD morbidity. Various body composition methods are available to estimate the size of whole body muscle mass. Like other COPD assessment tools, expensive, invasive laboratory tests are generally more accurate than field tests. Evaluation of body composition methods is hampered by absence of a true gold standard except for ''carcass analysis''. New methods are therefore compared with reference methods that have proven to be highly accurate and precise for assessment of specific body compartments such as fat mass (*hydrostatic weighing*), total body water (*deuterium dilution*) and lean body mass *(total body potassium by whole body gamma counting)*. In this journal Rutten et al. present a critical view on diagnosing muscle wasting by bioelectrical impedance analysis (BIA) and appear to suggest that it is too early to implement body composition in clinical practice due to absence of appropriate reference values for fat-free mass (FFM). Is it indeed time to step back or should we move forward and even accelerate?

Stepping back

In 1985 Lukaski et al.[1] introduced bioelectrical impedance analysis as promising body composition method for clinical use since it is non-invasive, takes only a few minutes and requires no active collaboration of the patient. The analyzer is portable and relatively inexpensive. Concern was raised however about the validity of the method in patho physiological states including COPD. In 1991 we reported the first validation study of BIA in clinically stable patients with COPD using deuterium dilution as reference method.[2] This is a logical reference since the principle of BIA is based upon the conductance through body fluids of an electrical current and theoretically total body water is linearly related to height^2/body resistance or height^2/body impedance[1] assuming that the Capacitance (Xc) is small relative to resistance. Thereafter we performed several other methodological studies specifically focusing on the potential influence of shifts in body water compartments on validity of BIA in COPD[3] and in other chronic wasting diseases including cancer[4] and chronic heart failure.[5] As was also concluded by the ESPEN working group on bioelectrical impedance analysis in 2004,[6] our studies collectively suggest that BIA works well in healthy subjects and in patients with stable water and electrolytes balance with a validated BIA equation that is appropriate with regard to age, sex and race. While initially developed as part of the validation studies, there is yet no clear rationale for applying disease specific equations in clinically stable chronic wasting conditions including COPD. This facilitates comparative research and development of normal values for nutritional assessment. BIA is however not suitable in patients with extremely low FFMI (due to shrinkage of body cell mass[3]) or patients with extra cellular water expansion[3,6] irrespective of the underlying disease. In my opinion this short coming will not be improved by further BIA algorithms.

In this journal Rutten et al.[7] nevertheless step back and present a new COPD specific BIA prediction equation. The prediction equation was derived from a large sample of COPD patients. Methodological limitations of the study however preclude added value of this new disease specific formula. To develop a BIA prediction model, measurements of test and reference method should be performed exactly at the same moment, under the same circumstances[8] and not as indicated in the paper 'within two days'. While described as disease specific, we should bear in mind that this as well as previous COPD- prediction equations were derived from a selected group of Caucasian patients with severe COPD eligible for rehabilitation that does not cover the complete COPD spectrum. Most important and in contrast to earlier validation studies, the present study used dual energy X-ray absorptiometry (DEXA) as reference method. Although DEXA is an expensive laboratory test and often only available in a hospital setting, it is ignored that this technique was developed for assessment of bone mineral density and that estimates for fat-free mass and fat mass by DEXA are also derived from prediction equations using under water weighing as reference.

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DEXA is therefore just like BIA, a 'double indirect' body composition method. Rutten et al. also addressed the issue of cut off values to define normality of FFM. The relatively wide age range of their study population allowed comparison between 10 y-strata ranging from 40 to 80 years. Ageing resulted, as expected, in a decline in FFM which remarkably appeared to be most pronounced for the male sub-group. This observation calls for longitudinal analyses to investigate if, in the absence of apparent weight loss, the age related decline of FFM (often referred to as sarcopenia) in COPD is accelerated or similar to healthy age matched subjects. Body composition assessment is not only of interest for COPD to assess muscle mass as important determinant of physical functioning but also to assess the proportion and localization of fat mass as potential determinant of the increased cardiovascular disease risk. From that perspective it would have been interesting if Rutten et al. had used the large sample size of their study population and the DEXA method to compare the presented pattern of age related FFM decline with the pattern of fat mass, fat distribution and bone mass.

Moving forward

While field tests such as BIA and anthropometry have been extremely useful in large epidemiological cohort studies to identify 'hidden muscle wasting' in COPD and consistently showed the prognostic value of low muscle mass in COPD, current research and clinical care demand both a diagnostic screening tool as well as accurate methods to measure efficacy of intervention strategies on specific body compartments. For broad diagnostic screening I would propose to focus on application of two complimentary field tests (i.e anthropometry and BIA) with rigid application of standardized operation procedures and a rational choice for a suitable prediction formula. This choice may very well differ between centres or countries as is the case for other clinical assessment tools. The clear age dependency of body composition calls for application of age-adjusted percentiles to tailor clinical intervention strategies. So far we can fairly state that FFM-index values $<$10 percentile clearly reflect a high risk for physical disability as proposed by Janssen et al.[9] A broadening of research focus in COPD from cachexia to sarcopenia with a yet insufficiently known risk profile[10] could provide a rationale to broaden the cut off value to $<$ 25 percentile. Further methodological research is needed to assess accuracy and precision of methods in COPD that specifically focus on lower limb muscle mass such as PET scan, MRI and ultrasound. Unfortunately there is yet no clinical method available that can accurately assess body composition in abnormal hydration states. The BIA derived phase angle might qualify since it reflects the relative contributions of fluid (resistance) and cellular membranes (capacitance) of the human body.[11] In other chronic wasting conditions including advanced lung cancer[12] a low phase angle has been associated with poor prognosis and is proposed as screening tool for decreased cell integrity or even cell death. Evaluation of therapeutic interventions at an individual level is, even in normal hydrated subjects, still hampered by poor accuracy of individual methods to detect subtile changes in body composition. For research purposes, accuracy can be substantially improved by application of a 3 or 4 compartment model that incorporates measurements of total body water (*deuterium dilution or BIA*), total bone mineral content (*DEXA*) and body density (*hydrostatic weighing or air displacement plethysmography*) since this approach requires fewer assumptions than each of the individual methods.[13] From a clinical management and patient perspective a 2 compartment model will suffice since body composition is never the only outcome parameter of therapeutic interventions that target fat-free mass.

References

1. Lukaski HC, Johnson PE, Bolonchuk WW, Lykken GI. Assessment of fat-free mass using bioelectrical impedance measurements of the human body. *Am J Clin Nutr* 1985;**41**:810—7.
2. Schols AM, Wouters EF, Soeters PB, Westerterp KR. Body composition by bioelectrical-impedance analysis compared with deuterium dilution and skinfold anthropometry in patients with chronic obstructive pulmonary disease. *Am J Clin Nutr* 1991;**53**:421—4.
3. Baarends EM, Schols AM, van Marken Lichtenbelt WD, Wouters EF. Analysis of body water compartments in relation to tissue depletion in clinically stable patients with chronic obstructive pulmonary disease. *Am J Clin Nutr* 1997;**65**:88—94.
4. Simons JP, Schols AM, Westerterp KR, ten Velde GP, Wouters EF. The use of bioelectrical impedance analysis to predict total body water in patients with cancer cachexia. *Am J Clin Nutr* 1995;**61**:741—5.
5. Uszko-Lencer NH, Bothmer F, van Pol PE, Schols AM. Measuring body composition in chronic heart failure: A comparison of methods. *Eur J Heart Fail* 2006;**8**:208—14.
6. ESPEN Working group. Bioelectrical impedance analysis—part II: utilization in clinical practice. *Clin Nutr* 2004;**23**:1430—53.
7. Rutten EPA, Spruit M, Wouters EFM. Critical view on diagnosing muscle wasting by single frequency bioelectrical impedamce in COPD. *Respir Med* 2009. e-pub 31-7-2009.
8. Schols AMWJ, Dingemans AMC, Soeters PB, Wouters EFM. Within day variation of bioelectrical resistance measurements in patients with chronic obstructive pulmonary disease. *Clin Nutr* 1990;**9**:266—71.
9. Schols AM, Broekhuizen R, Weling-Scheepers CA, Wouters EF. Body composition and mortality in chronic obstructive pulmonary disease. *Am J Clin Nutr* 2005;**82**:53—9.
10. Schols AM. Schols AM. Nutritional rehabilitation: from pulmonary cachexia to sarcoPD. *Eur Respir J* 2009;**33**:949—50.
11. Baumgartner RN, Chumlea WC, Roche AF. Bioelectrical impedance phase angle and body composition. *Am J Clin Nutr* 1988;**48**:16—23.
12. Gupta D, Lammersfeld CA, Vashi PG, King J, Dahik SL, Grutsch JF, Gijs C. Bioelectrical impedance phase angle in clinical practice: implications for prognosis in stage IIB and IV non-small cell lung cancer. *BMC Cancer* 2009;**9**:37.
13. van Marken Lichtenbelt WD, Hartgens F, Vollaard NB, Ebbing S, Kuipers H. Body composition changes in body builders: a method comparison. *Med Sci Sports Exerc* 2004 Mar;**36**(3):490—7.

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